Chapter 6. Demersal Fishes and Megabenthic Invertebrates

INTRODUCTION

Marine fishes and invertebrates are conspicuous members of continental shelf habitats, and assessment of their communities has become an important focus of ocean monitoring programs throughout the world. Assemblages of bottom dwelling (demersal) fishes and relatively large (megabenthic), mobile invertebrates that live on the surface of the seafloor have been sampled extensively for more than 30 years on the mainland shelf of the Southern California Bight (SCB), primarily by programs associated with municipal wastewater and power plant discharges (Cross and Allen 1993). More than 100 species of demersal fish inhabit the SCB, while the megabenthic invertebrate fauna consists of more than 200 species (Allen 1982, Allen et al. 1998, 2002, 2007). For the region surrounding the South Bay Ocean Outfall (SBOO), the most common trawl-caught fishes include speckled sanddab, longfin sanddab, hornyhead turbot, California halibut, California lizardfish, and occasionally white croaker. Common trawl-caught invertebrates include various echinoderms (e.g., sea stars, sea urchins, sea cucumbers, and sand dollars), crustaceans (e.g., crabs and shrimp), molluscs (e.g., marine snails and octopuses), and other taxa.

Demersal fish and megabenthic invertebrate communities are inherently variable and may be influenced by both anthropogenic and natural factors. These organisms live in close proximity to the seafloor and are therefore exposed to contaminants of anthropogenic origin that may accumulate in the sediments via both point and non-point sources (e.g., discharges from ocean outfalls and storm drains, surface runoff from watersheds, outflows from rivers and bays, disposal of dredge materials). Natural factors that may affect assemblages of these fish and invertebrates include prey availability (Cross et al. 1985), bottom relief and sediment structure (Helvey and Smith 1985), and changes in water temperatures associated with large scale oceanographic events such as El Niño/La Niña oscillations (Karinen et al. 1985). These factors can affect migration patterns of adult fish or the recruitment of juveniles into an area (Murawski 1993). Population fluctuations that affect species diversity and abundance may also be due to the mobile nature of many species (e.g., schools of fish or aggregations of urchins).

The City of San Diego has been conducting trawl surveys in the area surrounding the SBOO since 1995. These surveys are designed to monitor the effects of wastewater discharge on the local marine biota by assessing the structure and stability of the trawl-caught fish and invertebrate communities. This chapter presents analyses and interpretations of the data collected during the 2007 trawl surveys.

Materials and Methods

Field Sampling

Trawl surveys were conducted at seven fixed monitoring sites around the SBOO (**Figure 6.1**). These surveys were conducted primarily during January, April, July, and October in 2007, although for the first quarter two stations (SD15 and SD16) were sampled in March instead of January. The seven stations, designated SD15–SD21, are located along the 28-m isobath, and encompass an area ranging form south of Point Loma, California (USA) to an area off Punta Bandera, Baja California (Mexico). During each survey a single trawl was performed at each station using a 7.6-m Marinovich otter trawl fitted with a 1.3-cm cod-end mesh net. The net was towed for 10 minutes bottom time at a speed of about 2.5 knots along a predetermined heading.

Trawl catches were brought on board for sorting and inspection. All fish and invertebrates were identified to species or to the lowest taxon possible. If an animal could not be identified in the field, it was returned to the laboratory for further identification. For fishes, the total number of individuals and total biomass (wet weight, kg) were recorded for each species.

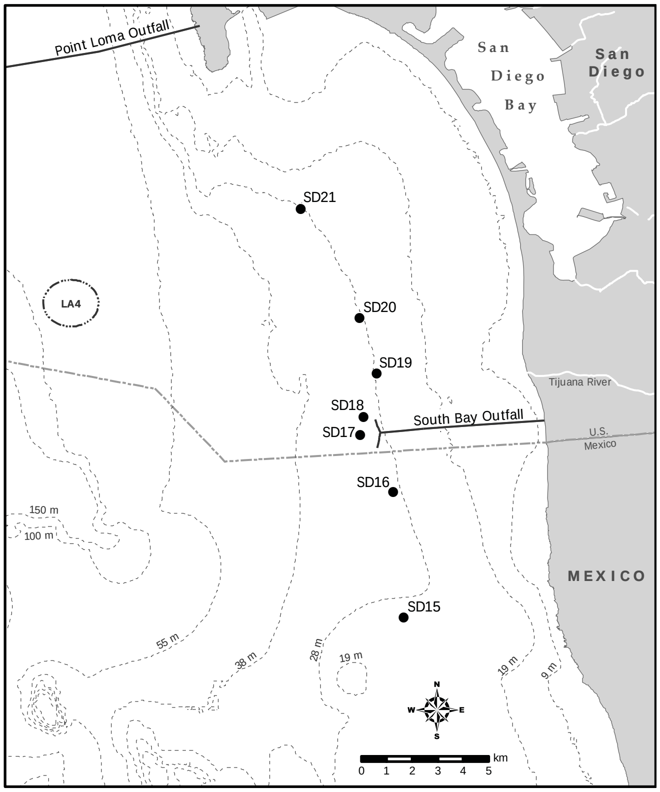

Figure 6.1
Otter trawl station locations, South Bay Ocean Outfall Monitoring Program.

Additionally, each individual fish was inspected for external parasites or physical anomalies (e.g., tumors, fin erosion, discoloration) and measured to the nearest centimeter size class (standard lengths). For invertebrates, the total number of individuals was recorded per species. Due to the small size of most organisms, invertebrate biomass was typically measured as a composite wet weight (kg) of all species combined; however, large or exceptionally abundant species were weighed separately.

Data Analyses

Populations of each fish and invertebrate species were summarized as percent abundance, frequency of occurrence, mean abundance per haul, and mean abundance per occurrence. In addition, species richness (number of species), total abundance, and Shannon diversity index (H') were calculated for both fish and invertebrate assemblages at each station. Total biomass was also calculated for each fish species by station.

Multivariate analyses were performed on 13 years of data from the July surveys of all seven stations. Data were limited to July surveys to eliminate seasonal differences. PRIMER software was used to examine spatio-temporal patterns in the overall similarity of fish assemblages in the region (see Clarke 1993, Warwick 1993). These analyses included classification (cluster analysis) by hierarchical agglomerative clustering with group-average linking, and ordination by non-metric multidimensional scaling (MDS). The fish abundance data were limited to species that occurred in at least 10 hauls, or had a station abundance of five or greater. The fish abundance data were square root transformed and the Bray-Curtis measure of similarity was used as the basis for classification. Because the species composition was sparse at some stations, a dummy species with a value of one was added to all samples prior to computing similarities (see Clarke and Gorley 2006).

Results

Fish Community

Twenty-nine species of fish were collected in the area surrounding the SBOO in 2007 (**Table 6.1**). The total catch for the year was 5260 individuals, representing an average of about 188 fish per trawl. Speckled sanddabs were the dominant fish captured, occurring in every haul and accounting for 68% of the total number of fishes collected during the year. Whereas speckled sanddabs averaged 128 fish per trawl, all other species averaged less than 15 per haul and less than 25 per occurrence. No other species contributed more than 7% of the total catch. Only hornyhead turbot, roughback sculpin, California lizardfish, longfin sanddab, English sole, yellowchin sculpin, California tonguefish, and California scorpionfish occurred in at least 50% of the trawls. The majority of species tended to be relatively small (average length <20 cm, see **Appendix D.1**). Larger species such as sharks, skates, and rays were relatively rare. These included the Pacific electric ray, thornback,

Table 6.1
Demersal fish species collected in 28 trawls in the SBOO region during 2007. PA=percent abundance; FO=frequency of occurrence; MAH=mean abundance per haul; MAO=mean abundance per occurrence.

Species	PA	FO	MAH	MAO	Species	PA	FO	MAH	MAO
Speckled sanddab	68	100	128	128	Bigmouth sole	<1	11	<1	2
Roughback sculpin	7	89	12	14	Kelp pipefish	<1	18	<1	1
Yellowchin sculpin	6	61	12	19	Spotted turbot	<1	21	<1	1
Longfin sanddab	5	75	10	13	Round stingray	<1	11	<1	1
California lizardfish	4	79	8	11	California skate	<1	11	<1	1
Hornyhead turbot	3	96	5	5	Shovelnose guitarfish	<1	7	<1	1
English sole	2	68	3	4	Specklefin midshipman	<1	7	<1	1
Longspine combfish	1	36	2	7	Unidentified flatfish	<1	7	<1	1
California scorpionfish	1	50	2	5	Big skate	<1	4	<1	1
California tonguefish	1	57	1	2	Giant kelpfish	<1	4	<1	1
Shiner perch	<1	4	1	21	Pacific electric ray	<1	4	<1	1
California halibut	<1	43	1	2	Pygmy poacher	<1	4	<1	1
Fantail sole	<1	43	1	1	Spotted cusk-eel	<1	4	<1	1
Plainfin midshipman	<1	43	1	1	Thornback	<1	4	<1	1
Pacific sanddab	<1	18	<1	2	White croaker	<1	4	<1	1

shovelnose guitarfish, California skate, big skate, and round sting ray.

During 2007, the number of fish species (species richness) and diversity (H') of fishes were relatively low, while abundance and biomass values varied widely in the region (**Table 6.2**). No more than 13 species occurred in any one haul, and H' values were less than ≤2.0 for the entire SBOO region. Station SD15 the lowest average species richness (7 species) and diversity (H'=0.51) values of all sites. Total abundance ranged from 62 to 397 fishes per haul, and co-varied with speckled sanddab populations that ranged from 28 to 275 fish per catch (City of San Diego 2008). Biomass ranged from 1.5 to 13 kg per haul, with higher biomass values coincident with either high numbers of fishes or the size of individual fishes. For example, the highest biomass value occurred at station SD21 in January when an 11 kg Pacific electric ray was captured (City of San Diego 2008). As with species richness and diversity, the lowest abundance and biomass values tended to occur at station SD15.

Although average species richness values for demersal fish in the SBOO region have remained within a narrow range over the years (i.e., 5–14 species per station per year), the total abundance per haul has fluctuated greatly (i.e., 28–275 individuals per station per year) in response to population fluctuations of a few dominant species (see **Figure 6.2, 6.3**). For example, the increase in average abundance per station that occurred between 2006 and 2007 (Figure 6.2), reflects a similar pattern in speckled sanddab populations (Figure 6.3). This trend reverses the substantial drop in the speckled sanddab catches that occurred from 2004 to 2006. Population fluctuations of common species such as the speckled sanddab tend to occur across the entire study area. In contrast, intra-station variability is most often associated with large hauls of schooling species that occur infrequently. For example, large hauls of white croaker were responsible for the high abundance at station SD21 in 1996, while a large haul of northern anchovy caused the relatively high abundance at station SD16 in 2001. Overall, none of the observed changes appear to be associated with the South Bay outfall.

Ordination and classification analyses were used to further examine changes in fish assemblages between 1995 and 2007. These analyses resulted in seven major cluster groups or assemblages (cluster

Table 6.2

Summary of demersal fish community parameters for SBOO stations sampled during 2007. Data are included for species richness (# of species), abundance (# of individuals), diversity (H'), and biomass (kg, wet weight).

Station	Jan*	Apr	Jul	Oct	Annual Mean	Annual SD
Species richness						
SD15	5	7	6	8	7	1
SD16	7	13	8	11	10	3
SD17	9	12	10	11	11	1
SD18	12	11	10	9	11	1
SD19	11	10	13	11	11	1
SD20	10	11	13	8	11	2
SD21	7	12	10	9	10	2
Survey Mean	9	11	10	10		
Survey SD	2	2	3	1		
Diversity						
SD15	0.33	0.56	0.44	0.72	0.51	0.17
SD16	0.45	1.23	0.61	0.94	0.81	0.35
SD17	1.39	1.51	1.02	1.27	1.30	0.21
SD18	1.41	1.61	0.98	1.13	1.28	0.28
SD19	0.90	1.03	1.00	1.11	1.01	0.09
SD20	1.17	1.59	1.28	1.28	1.33	0.18
SD21	1.34	1.77	1.27	1.04	1.36	0.30
Survey Mean	1.00	1.33	0.94	1.07		
Survey SD	0.45	0.42	0.32	0.20		

Station	Jan*	Apr	Jul	Oct	Annual Mean	Annual SD
Abundance						
SD15	170	149	86	139	136	36
SD16	124	182	172	261	185	57
SD17	159	179	208	357	226	90
SD18	123	178	155	238	174	49
SD19	105	259	195	333	223	97
SD20	117	204	195	98	154	54
SD21	62	141	274	397	219	148
Survey Mean	123	185	184	260		
Survey SD	36	39	57	112		
Biomass						
SD15	2.3	4.7	5.3	1.5	3.4	1.8
SD16	1.6	4.5	3.4	3.1	3.1	1.2
SD17	3.1	3.3	3.9	8.2	4.6	2.4
SD18	4.1	7.6	5.9	4.9	5.6	1.5
SD19	2.0	4.0	5.1	5.7	4.2	1.6
SD20	2.6	5.6	6.4	10.4	6.2	3.2
SD21	13.0	5.2	5.3	3.7	6.8	4.2
Survey Mean	4.1	5.0	5.0	5.4		
Survey SD	4.0	1.4	1.1	3.1		

* Stations SD15 and SD16 were actually sampled in March for the winter (i.e., January) survey.

groups A–G) (see **Figure 6.4**). The assemblages can be distinguished by differences in the relative abundances of common species that were present, although most are dominated by speckled sanddabs. The distribution of assemblages in 2007 was generally similar to that seen in previous years, especially during 2005 and 2006, and no patterns of change in fish assemblages in the SBOO region appear to be associated with the outfall. Instead, differences in the assemblages seem to be more closely related to large-scale oceanographic events (e.g., El Niño conditions in 1998) or specific station location. For example, station SD15 located far south of the outfall in northern Baja California waters often grouped apart from the remaining stations. The composition and characteristics of each cluster group are described below (**Table 6.3**).

Cluster group A comprised assemblages from the two northernmost stations (SD20 and SD21) sampled in 1995 as well as from every station except SD15 sampled during El Niño conditions in 1998. This group averaged the second fewest fish per haul (~64 individuals representing 9 species) and was characterized by the lowest abundance of speckled sanddabs (~12 fish/haul). The dominant species in this group was California lizardfish (~24 fish/haul) followed by longfin sanddabs (~12 fish/haul) and speckled sanddabs (as above).

Cluster group B comprised assemblages sampled from four stations sampled in 1997 (i.e., the southern stations SD15 and SD16, station SD17 near the outfall, and northern station SD20), station SD15 from 1998, and every station except SD21 during July 2001. Overall, this group averaged the fewest fish per haul (36 fishes representing 7 species). The dominant species in this group was the speckled sanddab (~23 fish/haul), although this species occurred in relatively low numbers compared to most other groups (i.e., cluster groups C–G). Overall, this group was

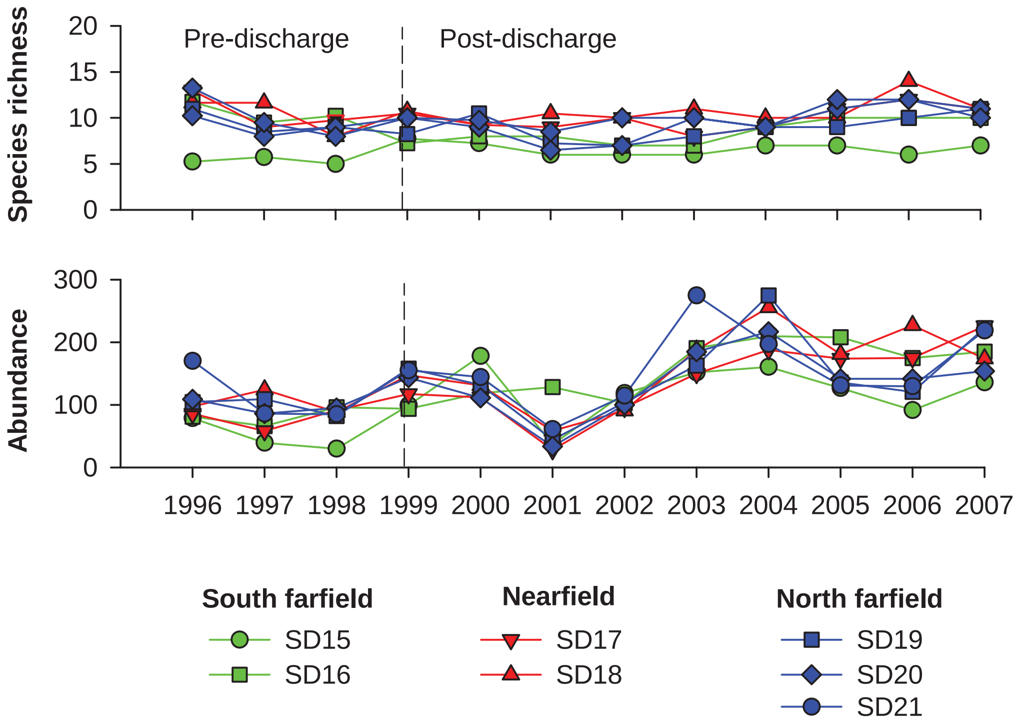

Figure 6.2
Species richness (number of species) and abundance (number of individuals) of demersal fish collected at each SBOO trawl station between 1996 through 2007. Data are annual means, n=4. Dotted line represents initiation of wastewater discharge.

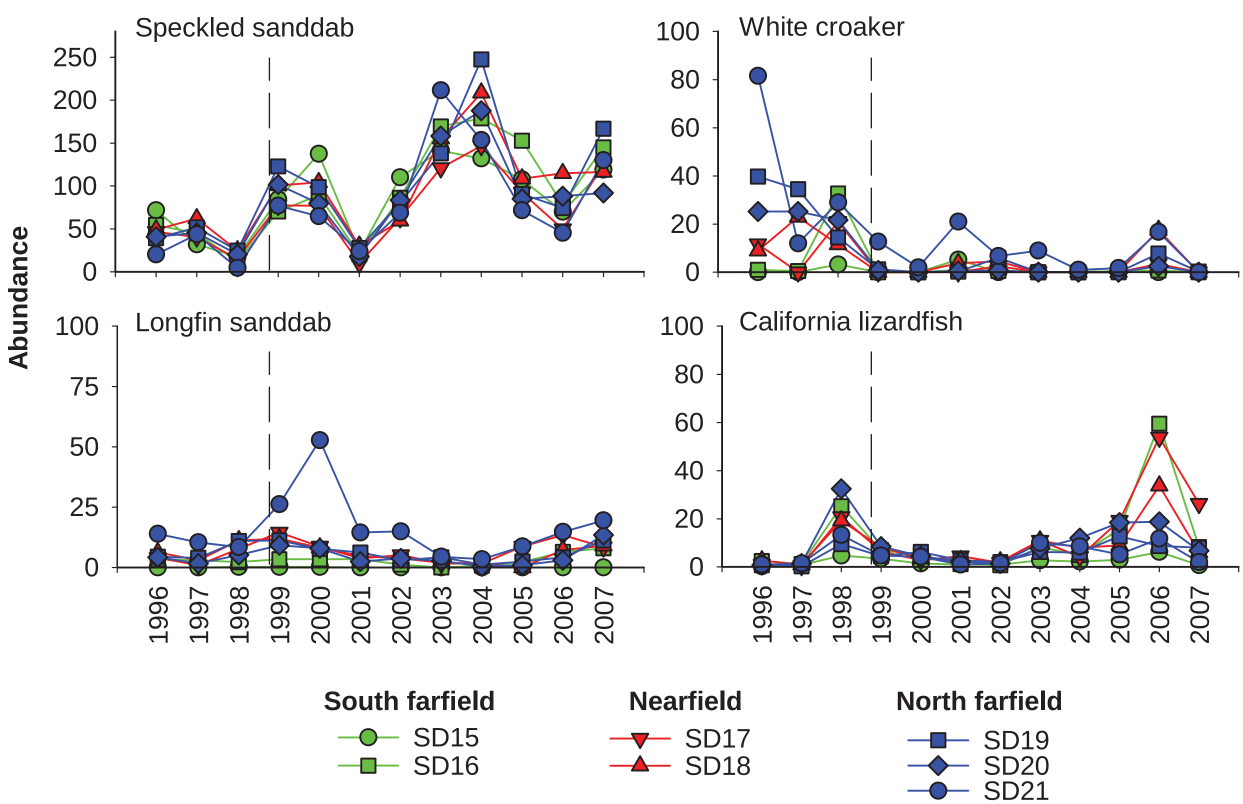

Figure 6.3
Abundance (number of individuals) of the four most abundant fish species collected in the SBOO region from 1996 through 2007. Data are annual means per station, n=4. Dotted line represents initiation of wastewater discharge.

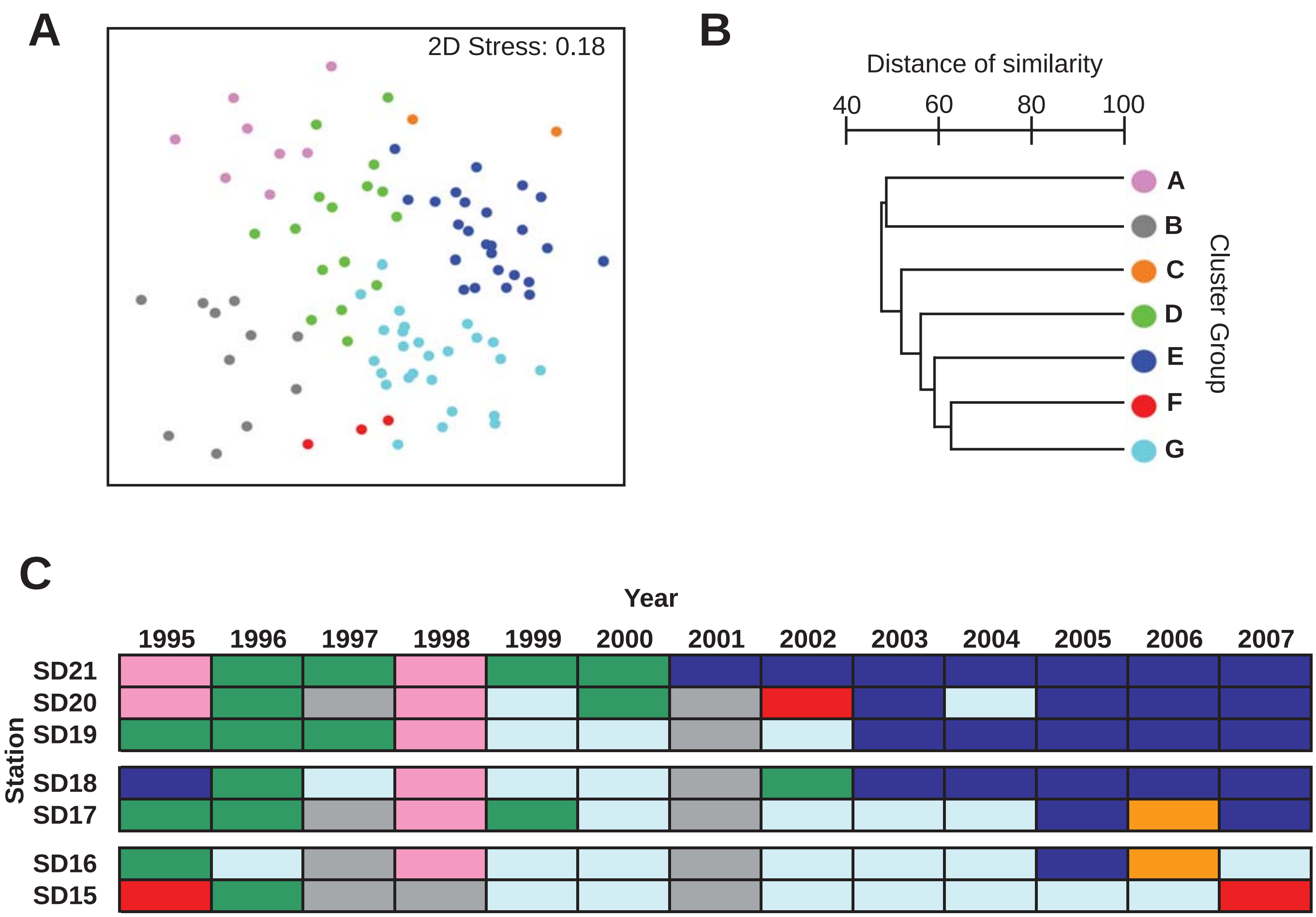

Figure 6.4

Results of classification analysis of demersal fish assemblages collected at SBOO stations SD15–SD21 between 1995 and 2006 (July surveys only). Data are presented as (A) MDS ordination, (B) a dendrogram of major cluster groups and (C) a matrix showing distribution of cluster groups over time.

characterized by low average abundances (≤3 fish/haul) for all other species.

Cluster group C consisted of assemblages from only stations SD16 and SD17 sampled in July 2006. This group was unique in that it was characterized by more than 200 California lizardfish per haul, which was almost twice as many as captured in any other trawl analyzed herein. The second and third most abundant species in this group were the speckled sanddab (~56 fish/haul) and yellowchin sculpin (~15 fish/haul).

Cluster group D represented assemblages from a mix of stations surveyed between 1995 and 2002. These included nine of the 14 station-surveys during 1995–1996 (i.e., representing all seven sites), two stations each during 1997 (SD19, SD21), 1999 (SD17, SD21) and 2000 (SD20, SD21), and one station in 2002 (SD18). Similar to most other groups, the dominant species was the speckled sanddab (~55 fish/haul). Group D was also characterized by about twice as many longfin sanddabs (~24 fish/haul) as that occurred in other groups.

Cluster group E comprised assemblages from about 63% of the trawls performed from 2003 through 2007, as well as one trawl each during 1995, 2001 and 2002. This group averaged the highest number of species overall (~10 species/haul) and was characterized by the highest number of speckled sanddabs (~140 fish/haul). Aside from speckled sandabs, the second and third most abundant species characterizing this group were yellowchin sculpin (~20 fish/haul) and California lizardfish (~14 fish/haul).

Table 6.3

Description of cluster groups A–G defined in Figure 6.4. Data include number of hauls, mean species richness, mean total abundance, and mean abundance of the five most abundant species for each station group (indicated in bold).

	Group A	Group B	Group C	Group D	Group E	Group F	Group G
Number of hauls	8	11	2	16	25	3	26
Mean species richness	9	7	8	9	10	4	6
Mean abundance	64	36	298	106	207	69	141
Species				**Mean Abundance**			
Speckled sanddab	**12**	**23**	**56**	**55**	**140**	**63**	**126**
California lizardfish	**24**	**2**	**212**	2	**14**		**4**
Hornyhead turbot	**3**	**3**	**4**	**5**	**5**	**2**	**4**
Spotted turbot	1	**2**		2	1		**2**
Roughback sculpin			3		4		**1**
California tonguefish	2	1	3	**4**	3		**1**
California scorpionfish	<1	**2**	1	1	1	**1**	**1**
Fantail sole	1	<1		1	<1	<1	**1**
English sole	**5**	<1	2	3	4		<1
Longfin sanddab	**12**	<1	**5**	**24**	**12**		<1
Yellowchin sculpin	1		**15**	<1	**20**	<1	<1
California skate	<1	<1			<1	**1**	<1
White croaker				**4**			<1
Plainfin midshipman				1	1	<1	<1
Thornback	<1	<1				<1	<1

Cluster group F consisted of assemblages from only three trawls, including those from station SD15 sampled in 1995 and 2007, and station SD20 sampled in 2002. Overall, this group was characterized by the lowest species richness (~4 species/haul) and the third lowest average abundance (~69 fish/haul). The dominant species in this group was the speckled sanddab (~63 fish/haul), while all other species occurred in very low numbers (≤2 fish/haul).

Cluster group G was represented by assemblages that occurred at a mix of sites sampled during all years except 1995, 1998 and 2001. This included a majority of stations from 1999, 2000, 2002 and 2004. Group G was characterized by third highest average abundance (~141 fish/haul), but the second lowest species richness (~6 species/haul). This group was similar to group E in that it was dominated almost exclusively by speckled sanddabs (~126 fish/haul), although all other species, including longfin sanddabs, occurred in much lower numbers (≤4 fish/haul).

Physical Abnormalities and Parasitism

Demersal fish populations appeared healthy in the SBOO region during 2007. There were no incidences of fin rot, discoloration, skin lesions, tumors or any other physical abnormalities or indicators of disease among fishes collected during the year. Evidence of parasitism was also very low for trawl-caught fishes in the region. Only one external parasite was observed still attached to its host; a leech (Annelida, Hirudinea) was found attached to a hornyhead turbot at station SD21. However, other leeches, as well the cymothoid isopod *Elthusa vulgaris*, were observed loose in some trawls. Both types of ectoparasites often become detached from their hosts during sorting of the trawl catch, and therefore it is unknown which fishes were actually parasitized. Although *E. vulgaris* is known to occur on a variety of fish species in southern California waters, it is especially common on sanddabs and California lizardfish, where it may reach infestation rates of 3% and 80%, respectively (Brusca 1978, 1981).

Invertebrate Community

A total of 867 megabenthic invertebrates (~31 per trawl), representing 53 taxa, were collected during 2007 (**Appendix D.2**). The sea star *Astropecten verrilli* was the most abundant and most frequently captured species. This sea star

Table 6.4
Species of megabenthic invertebrates collected in 28 trawls in the SBOO region during 2007. PA=percent abundance; FO=frequency of occurrence; MAH=mean abundance per haul; MAO=mean abundance per occurrence.

Species	PA	FO	MAH	MAO	Species	PA	FO	MAH	MAO
Astropecten verrilli	55	89	17	19	*Megastraea turbanica*	<1	7	<1	2
Philine auriformis	6	18	2	10	*Pugettia producta*	<1	7	<1	2
Cancer gracilis	4	32	1	4	HIRUDINEA	<1	11	<1	1
Crangon nigromaculata	4	54	1	2	*Luidia armata*	<1	7	<1	2
Cancer sp	2	11	1	7	*Acanthodoris rhodoceras*	<1	7	<1	1
Pisaster brevispinus	2	50	1	1	*Calliostoma gloriosum*	<1	7	<1	1
Lytechinus pictus	2	21	1	3	*Crangon alba*	<1	7	<1	1
Heterocrypta occidentalis	2	21	1	3	*Dendronotus iris*	<1	7	<1	1
Acanthodoris brunnea	2	7	1	7	*Paguristes bakeri*	<1	7	<1	1
Elthusa vulgaris	2	29	1	2	*Thesea* sp B	<1	7	<1	1
Kelletia kelletii	1	32	<1	1	*Alpheus clamator*	<1	4	<1	1
Pyromaia tuberculata	1	18	<1	3	*Aphrodita refulgida*	<1	4	<1	1
Hemisquilla californiensis	1	32	<1	1	*Aphrodita* sp	<1	4	<1	1
Ophiothrix spiculata	1	18	<1	2	ASCIDIACEA	<1	4	<1	1
Platynereis bicanaliculata	1	4	<1	10	*Cancellaria crawfordiana*	<1	4	<1	1
Platymera gaudichaudii	1	21	<1	2	*Crangon alaskensis*	<1	4	<1	1
Farfantepenaeus californiensis	1	11	<1	3	*Flabellina iodinea*	<1	4	<1	1
Crossata californica	1	14	<1	2	*Flabellina pricei*	<1	4	<1	1
Octopus rubescens	1	11	<1	2	*Florometra serratissima*	<1	4	<1	1
Podochela hemphillii	1	21	<1	1	*Luidia asthenosoma*	<1	4	<1	1
Dendraster terminalis	1	14	<1	1	*Norrisia norrisi*	<1	4	<1	1
Heptacarpus palpator	1	11	<1	2	*Ocinebrina foveolata*	<1	4	<1	1
Pagurus spilocarpus	1	18	<1	1	*Pinnixa franciscana*	<1	4	<1	1
Randallia ornata	1	14	<1	1	*Pylopagurus holmesi*	<1	4	<1	1
Cancer anthonyi	<1	11	<1	1	*Sicyonia penicillata*	<1	4	<1	1
Euspira lewisii	<1	14	<1	1	*Triopha maculata*	<1	4	<1	1
Loxorhynchus grandis	<1	11	<1	1					

was captured in 89% of the trawls and accounted for 55% of the total invertebrate abundance (**Table 6.4**). Another sea star, *Pisaster brevispinus*, occurred in 50% of the trawls but accounted for only 2% of the total abundance. The shrimp, *Crangon nigromaculata,* occurred in 54% of the trawls. The remaining taxa occurred infrequently, with only eight occurring in 20% or more of the hauls. With the exception of *A. verrilli*, all of the species collected averaged no more than two individuals per haul or 10 individuals per occurrence. Two species that usually do not occur in South Bay trawls, the nereid polychaete *Platynereis bicanaliculata,* and the pea crab *Pinnixa franciscana*, were collected at station SD20 in October 2007. These two species were apparently feeding on squid eggs that were also collected at this trawl site.

Megabenthic invertebrate community structure varied among stations and between surveys during the year (**Table 6.5**). Species richness ranged from 4 to 12 species per haul, diversity (H') values ranged from 0.3 to 2.29 per haul, and total abundance ranged from 11 to 120 individuals per haul. The biggest hauls were characterized by large numbers of *A. verrilli*, particularly during October when abundances of this sea star reached 108 individuals per haul. Although biomass was also somewhat variable (0.1–3.0 kg), the highest values generally corresponded to the collection of relatively large sea stars (e.g., *P. brevispinus*) or crabs (e.g., *Cancer* sp, *Loxorhynchus grandis*).

Table 6.5

Summary of megabenthic invertebrate community parameters for SBOO stations sampled during 2007. Data are included for species richness (number of species), abundance (number of individuals), diversity (H') and biomass (kg, wet weight).

Station	Jan*	Apr	Jul	Oct	Annual Mean	Annual SD
Species richness						
SD15	6	5	7	6	6	1
SD16	10	4	5	5	6	3
SD17	9	8	10	4	8	3
SD18	9	7	12	11	10	2
SD19	6	4	9	6	6	2
SD20	9	7	6	6	7	1
SD21	6	8	11	11	9	2
Survey Mean	8	6	9	7		
Survey SD	2	2	3	3		
Diversity						
SD15	0.98	0.53	0.47	0.45	0.61	0.25
SD16	2.14	0.30	0.84	1.26	1.14	0.78
SD17	2.07	1.91	1.32	1.09	1.60	0.46
SD18	1.97	1.51	1.89	2.10	1.87	0.25
SD19	1.42	0.66	1.23	1.57	1.22	0.40
SD20	1.99	1.77	1.33	1.38	1.62	0.32
SD21	1.57	1.77	2.29	2.12	1.94	0.33
Survey Mean	1.73	1.21	1.34	1.43		
Survey SD	0.43	0.68	0.61	0.59		

Station	Jan*	Apr	Jul	Oct	Annual Mean	Annual SD
Abundance						
SD15	34	55	84	120	73	37
SD16	14	63	18	13	27	24
SD17	14	14	51	31	28	18
SD18	14	19	37	29	25	10
SD19	11	17	39	19	22	12
SD20	20	11	20	42	23	13
SD21	14	15	20	29	20	7
Survey Mean	17	28	38	40		
Survey SD	8	22	24	36		
Biomass						
SD15	0.9	0.1	0.9	0.4	0.6	0.4
SD16	1.0	0.7	0.5	1.1	0.8	0.3
SD17	1.1	1.3	0.3	0.1	0.7	0.6
SD18	0.1	0.6	0.6	0.7	0.5	0.3
SD19	0.3	0.5	1.2	0.4	0.6	0.4
SD20	2.3	0.5	0.2	0.2	0.8	1.0
SD21	0.8	0.6	0.1	3.0	1.1	1.3
Survey Mean	0.9	0.6	0.5	0.8		
Survey SD	0.7	0.4	0.4	1.0		

* Stations SD15 and SD16 were actually sampled in March for the winter (i.e., January) survey.

Variations in megabenthic invertebrate community structure in the South Bay area generally reflect changes in species abundance (**Figures 6.5, 6.6**). Although species richness has varied little over the years (e.g., 4–14 species/trawl), annual abundance values have averaged between 7 and 273 individuals per haul. These large differences are generally due to fluctuations in populations of several dominant species, especially the sea star *A. verrilli*, the sea urchin *Lytechinus pictus*, the sand dollar *Dendraster terminalis*, and the shrimp *C. nigromaculata* (Figure 6.6). For example, station SD15 has had the highest average abundance compared to the other stations for seven out of 13 years due to relatively high abundances of *A. verrilli*, *L. pictus* and *D. terminalis*. In addition, the high abundances recorded at station SD17 in 1996 were due to large hauls of *L. pictus*. None of the observed variability in the invertebrate communities appears to be related to the South Bay outfall.

Summary and Conclusion

As in previous years, speckled sanddabs continued to dominate fish assemblages surrounding the SBOO during 2007. This species occurred at all stations and accounted for 68% of the total catch. Other characteristic, but less abundant species included the hornyhead turbot, roughback sculpin, California lizardfish, longfin sanddab, English sole, yellowchin sculpin, California tonguefish, and California scorpionfish. Most of these common fishes were relatively small, averaging less than 20 cm in length. Although the composition and structure of the fish assemblages varied among stations, these differences were mostly due to variations in speckled sanddab populations.

Assemblages of relatively large (megabenthic) trawl-caught invertebrates in the region were similarly dominated by one prominent species,

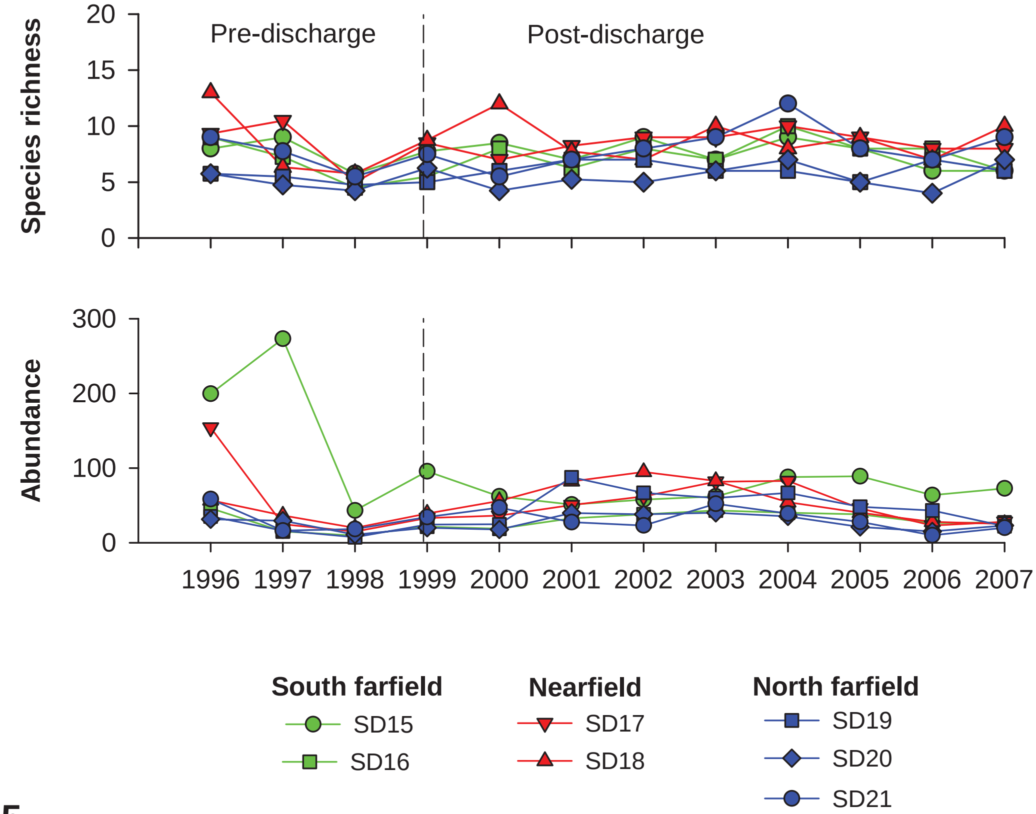

Figure 6.5

Species richness (number of species) and abundance (number of individuals) of megabenthic invertebrates collected at each station between 1996 through 2007. Data are annual means, n=4. Dotted line represents initiation of wastewater discharge.

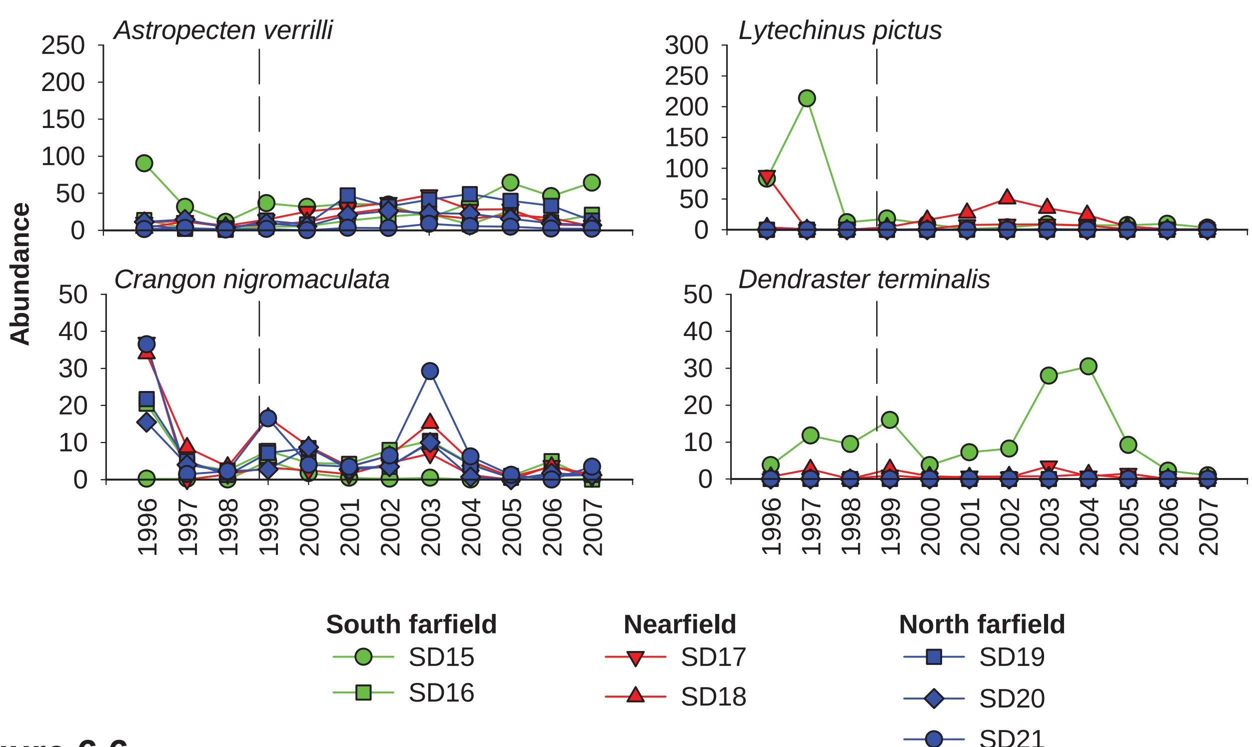

Figure 6.6

Abundance (number of individuals) of the four most abundant megabenthic species collected in the SBOO region from 1996 through 2007. Data are annual means per station, n=4. Dotted line represents initiation of wastewater discharge.

Astropectin verrilli. Variations in community structure of these trawl-caught invertebrates generally reflect changes in the abundance of this sea star, as well as other dominant species such as *Lytechinus pictus*, *Dendraster terminalis,* and *Crangon nigromaculata.*

The low species richness and abundances of fish and invertebrates found during the 2007 surveys are consistent with what is expected for the relatively shallow, sandy habitats in which the SBOO stations are located (see Allen et al. 1998, 2002, 2007). In contrast, trawl surveys for the Point Loma Ocean Outfall region include deeper stations located farther offshore on the mainland shelf that contain finer sediments, and that typically result in higher species richness and abundance values. For example, the mean number of fish species collected per haul off Point Loma often reaches 23 species per station with mean abundances up to 1368 individuals (see City of San Diego 2006).

Overall, results of the 2007 trawl surveys provide no evidence that wastewater discharged through the SBOO has affected either demersal fish or megabenthic invertebrate communities in the region. Although highly variable, patterns in the abundance and distribution of species were similar at stations located near the outfall and farther away, indicating a lack of any significant influence due to the outfall. Changes in these communities appear to be more likely due to natural factors such as changes in water temperature associated with large-scale oceanographic events (e.g., El Niño) or to the mobile nature of many of the resident species collected. Finally, the absence of disease or other physical abnormalities in local fishes suggests that populations in the area continue to be healthy.

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